Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
A99.9
F764Un
cop. 2

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

FEB 4 1970

CURRENT SERIAL RECORDS

Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN, UTAH 84401

USDA Forest Service
Research Note INT-104 1969

CONVERTING GAMBEL OAK SITES TO GRASS REDUCES SOIL-MOISTURE DEPLETION

Ronald K. Tew[1]

ABSTRACT

Replacement of Gambel oak (Quercus gambelii *Nutt.) with grass on an experimental plot in northern Utah resulted in a reduction of soil-moisture depletion by 3.09 inches the first year and 2.35 inches the second year. Moisture savings occurred primarily in the lower 4 feet of the 8-foot measured soil profile. In contrast to the moisture-savings on this grass-covered plot, a plot containing 2-year-old oak sprouts used only about 0.4 inch less soil moisture during the growing season than would a mature oak stand on the same site.*

Information regarding soil-moisture depletion by various types of vegetation is important to the development of forest management practices designed for water-yield improvement. Prior to a conversion of vegetation for increased water yields, even on a limited basis, the potential benefits and limitations of such a conversion must be known to ensure success. This study was undertaken to evaluate changes in soil-moisture depletion before and after conversion of Gambel oak sites to grass in northern Utah. Soil-moisture depletion by mature oak stands on this site[2] and by mature and sprout stands of oak in central Utah[3] were measured and reported upon previously.

---

[1] Former Associate Plant Physiologist, stationed in Logan, Utah, at Forestry Sciences Laboratory, maintained in cooperation with Utah State University. Now serving as Soil Scientist with the USDA Soil Conservation Service, Manti, Utah.

[2] Tew, Ronald K. Soil moisture depletion by Gambel oak in northern Utah. USDA Forest Serv. Res. Note INT-54, 7 pp. 1966.

[3] Tew, Ronald K. Soil moisture depletion by Gambel oak in central Utah. USDA Forest Serv: Res. Note INT-74, 8 pp. 1967.

295214

METHODS

The study area, previously described by Tew,[2] consisted of three 0.1 acre plots located at an elevation of 7,100 feet in northern Utah. Runoff tanks were installed at the foot of each plot. Nine soil moisture access tubes were inserted to a depth of 8 feet on each plot to permit use of the neutron probe to make moisture measurements. The measurements taken between 1962 and 1965 were used for calibrating soil-moisture relations between the three Gambel oak covered plots in their untreated condition. Regression equations were developed which related average moisture content in the depth intervals of 0 to 4 feet and 4 to 8 feet on plot 1 to that on either plot 2 or 3, thus providing an accurate means of evaluating later treatment effects. Correlation coefficients exceeded 0.99 for all equations.

The three plots were treated in the fall of 1965. The mature oak was left on plot 1 as a control, but was clearcut and removed from plots 2 and 3. Oak was allowed to resprout on plot 2. On plot 3, these 5 grass species were planted immediately following oak removal: tall oatgrass (Arrhenatherum elatius (L.) Presl); orchardgrass (Dactylis glomerata L.); smooth brome (Bromus inermis Leyss.); intermediate wheatgrass (Agropyron intermedium (Host) Beauv.); and timothy (Phleum pratense L.). In the spring of 1966 a mixture of 2,4-D and 2,4,5-T was used to spray broadleafed vegetation, young oak sprouts, and tree stumps on the seeded plot. This plot was sprayed again in mid-summer to eliminate new oak sprouts.

RESULTS

Sediment and Runoff

There was neither measurable sediment production nor measurable overland flow from the plots during the 6 years of this experiment; this was true before and after the site conversion from oak to grass. However, no high-intensity summer storms were recorded during the spring of 1966 when grass was becoming established and ground cover was sparse on plots 2 and 3.

Soil-Moisture Use by Oak Sprouts

The regression equations developed from data gathered previous to treatment were used to predict soil-moisture contents and accurately measure the effect of oak removal on soil-moisture depletion. It was possible to detect differences of approximately 0.1 inch in soil-moisture use at the 5-percent level of significance.

The changes in soil-moisture depletion which occurred during the first 2 years following clearcutting and subsequent sprout establishment on plot 2 are shown in table 1. During 1966, the first year after clearcutting, evapotranspirational loss from the sprout stand was 1.04 inches less than would have occurred if mature oak occupied that plot. This represented a moisture savings of 0.33 inch in the 0- to 4-foot soil depth and 0.71 inch in the 4- to 8-foot depth as a result of changing oak age classes. In 1967 there was no significant difference between mature oak and sprouts in the amount of soil moisture lost from the upper 4 feet of soil, although the sprout stand did use 0.06 inch more than expected for a mature stand. However, in the lower depth interval under the sprouts a significant savings of 0.44 inch was noted.

Table 1.--Moisture content in the soil profile at the end of the first and second growing seasons following treatment

	Plot 2: Oak sprouts				Plot 3: Grass			
	1966		1967		1966		1967	
	0-4 ft.	4-8 ft.	0-4 ft.	4-8 ft.	0-4 ft.	4-8 ft.	0-4 ft.	4-8 ft.
	Inches							
Predicted[1] (for mature oak)	5.41	7.03	5.32	7.37	5.19	5.92	5.11	6.10
Measured	5.74	7.74	5.26	7.81	6.46	7.74	5.33	8.23
Difference	0.33	0.71	-0.06	0.44	1.27	1.82	0.22	2.13
Total moisture savings	1.04		0.38		3.09		2.35	

[1] Based on regression equations developed prior to treatment using plot 1 as a control.

Soil-Moisture Use by Grass

The inherent moisture-holding capacity of the soil on plot 3 was considerably less than on the other two plots (mature oak and oak sprouts), with the greatest difference occurring in the 4- to 8-foot depth. Prior to treatment, the oak on plot 3 was less vigorous and less densely populated than on the two adjacent plots, probably as a result of having less soil moisture available to it.

Plot 3 was relatively bare during the early part of the first growing season following oak removal; but, by September the sown grass was well established and appeared to fully occupy the site. All five of the introduced species were well represented. However, intermediate wheatgrass was the dominant species and produced the greatest amount of vegetation.

During 1966, total soil-moisture depletion on plot 3 (grass) was 3.09 inches less than would be expected for mature oak on that site; the greatest conservation of moisture was in the lower 4 feet of soil although a reduction in soil-moisture depletion also occurred in the upper 4 feet (table 1).

In 1967, 2.35 inches more soil moisture were present in the 8-foot profile on plot 3 at the end of the growing season than would be expected if mature oak had been present. Essentially the same amount of moisture was conserved in the lower 4 feet during this second year (1967) as in the first year. However, moisture savings in the upper 4 feet of soil was reduced during this second growing season.

DISCUSSION

Moisture depletion was essentially the same in the upper 4 feet of soil when either oak or grass occupied the site. Nearly 60 percent less moisture was lost from the lower 4 feet of soil following oak eradication. However, even after oak eradication, approximately 1.6 inches of soil moisture were lost from these lower depths. Deep seepage probably accounted for much of this, as grass roots were concentrated in the upper 4 feet.

To achieve a substantial decrease in soil-moisture depletion, oak must be completely eradicated because oak sprouts use nearly as much moisture as mature stands. However, even when oak is eradicated and the site sown to grass, the quantity of moisture saved is dependent upon the soil depth and its inherent moisture-holding properties. For example, the soil under plot 3 had low moisture-holding capacity in the lower 4 feet when compared to either plot 1 or 2. If either plot 1 or 2 (with their higher moisture content) had been converted to grass, a larger treatment effect might have been realized than was obtained by converting plot 3.

After conversion to a shallow-rooted vegetation, such as some grasses, seepage would still occur deep in the soil profile even though evapotranspirational losses would be reduced. It would, therefore, be erroneous to assume that all soil-moisture losses in the lower 4 feet of soil can be eliminated by converting oak sites to grass, even though grass roots do not reach depths equal to the oak roots. Soil-moisture depletion due to evapotranspiration is true loss with respect to water yield from the watershed. However, soil-moisture depletion due to deep seepage, as probably occurred from the lower depths of plot 3 after its conversion to grass, is not a loss; instead, this deep seepage is a gain if it ultimately appears as streamflow, or if it becomes ground-water that can be utilized.